

Parasympathetic ganglia in the head of western hedgehog *Erinaceus europaeus*. II. Pterygopalatine ganglion

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Using the thiocholine method of Koelle and Friedenwald, and histological techniques the pterygopalatine ganglion of the western hedgehog *Erinaceus europaeus* from the Wrocław Province was studied. The ganglion was found to be a dense, elongated aggregation of neurocytes, 3-4 mm long and 0.5-1.0 mm broad. The ganglion is very tightly attached to the pterygopalatine nerve by connective tissue.

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Introduction

This paper presents continuation of research on the parasympathetic cephalic ganglia in the western hedgehog *Erinaceus europaeus* Linnaeus, 1758 (Gienc *et al.* 1988). Due to substantial differences in the morphology and topography of the pterygopalatine ganglion in mammals, this structure in the hedgehog, as a representative of the most primitive placentalia, from which more specialized orders descend, was studied.

Material and methods

Research was carried out on eight adult western hedgehogs of both sexes. The animals were killed by decapitation under ether anaesthesia. For histochemical examination five animals were used. The area of the trigeminal nerve was exposed carefully by dissection. This material was studied *in situ* by the thiocholine method of Koelle-Friedenwald (1948), modified by Gienc (1976, 1977) for use in macromorphological specimens. From the remaining three animals, tissues were taken for histological examination. The sections were embedded in paraffin and cut serially at 10 μ m thickness in a microtome. Staining was done by Nissl's method.

Results

As macroscopic examination has shown, the pterygopalatine ganglion in the hedgehog is so tightly bound to the pterygopalatine nerve by connective tissue that together they create a dense, elongated structure, situated along the upper edge of the maxillary nerve (Fig. 1, 2 and 3). Histological cross-sections show very clearly that connective tissue forms both a sheath surrounding these structures and separates them from the maxillary nerve (Fig. 4 A-D). Transverse histological cross-sections show even better the relation between the ganglion and the nerve. Cells making up the caudal and the intermediate part of the ganglion are in close contact with the dorsal and lateral

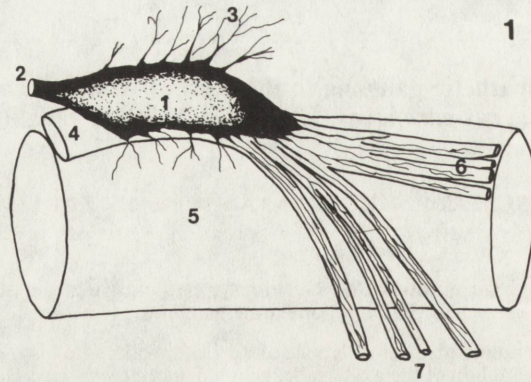


Fig. 1. Scheme drawing showing the shape and site of the pterygopalatine ganglion in the hedgehog. 1 — pterygopalatine ganglion, 2 — major petrosal nerve, 3 — postganglionic bundles to Harderian gland, 4 — pterygopalatine nerve, 5 — maxillary nerve, 6 — nasal branches, 7 — palatine branches.

part of the pterygopalatine nerve (Fig. 4 A – C), whereas the rostral part of the ganglion is in contact with only the dorsal part of the nerve (Fig. 4D). Figures 4 A – D show that one of the bundles of the pterygopalatine nerve gradually diverges from the others towards the nasal part of the nerve and comes to lie within the ganglion. Connective tissue, which in the hedgehog is very abundant, makes histochemical examination difficult because it hinders passage of the histochemical agents and thus prevents cholinergic structures from being deeply stained. Therefore the pterygopalatine ganglion in the hedgehog is poorly and unevenly stained (Fig. 2 and 3). In all the cases examined, only the nasal part of the ganglion and the numerous bundles of postganglionic fibres emerging from this part and joining with nasal and palatine ramifications were intensely stained (Fig. 2 and 3). Also intensely stained, but less numerous were clusters of postganglionic nerve fibres emerging from the upper edge of

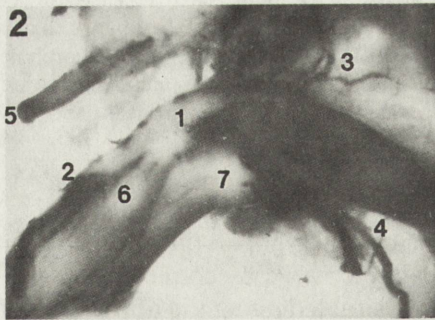


Fig. 2. The pterygopalatine ganglion in hedgehog. Left side. Thiocholine method. Magnification about $16\times$.

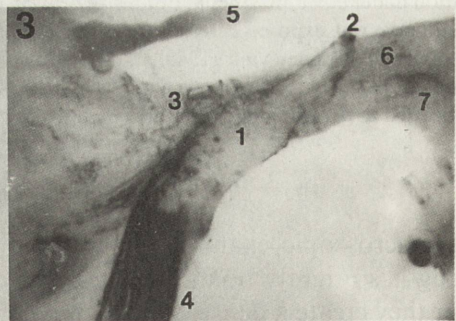


Fig. 3. The pterygopalatine ganglion in hedgehog. Right side. Thiocholine method. Magnification about $16\times$.

1 — pterygopalatine ganglion, 2 — major petrosal nerve, 3 — postganglionic bundles to Harderian gland, 4 — nasal and palatine branches, 5 — optic nerve, 6 — pterygopalatine nerve, 7 — maxillary nerve.

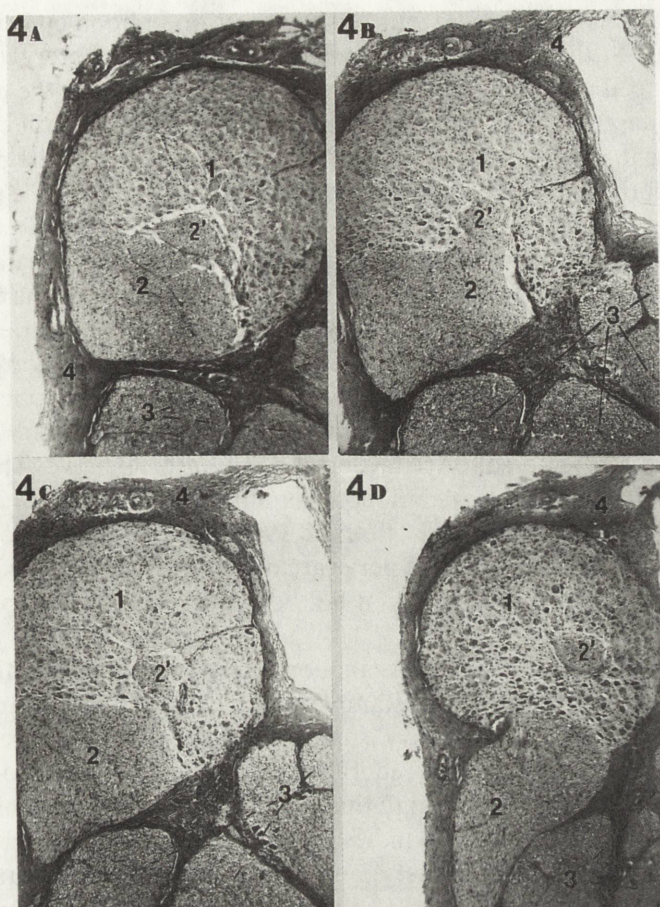


Fig. 4. Cross-sections through the pterygopalatine ganglion of a hedgehog. Left side. Nissl's stain. Magnif. about $75\times$. A — caudal part, B, C — medial parts, D — nasal part, 1 — ganglionic neurons, 2 — pterygopalatine nerve, 2' — bundles of the pterygopalatine nerve, 3 — maxillary nerve, 4 — connective tissue capsula of the ganglion.

the ganglion and passing towards the gland of Harder (Fig. 1, 2 and 3). The petrosal major nerve enters the caudal end of the ganglion (Fig. 1, 2 and 3). The pterygopalatine ganglion in the hedgehog is oval-shaped, with very distinctly marked nasal and caudal ends, and is 3–4 mm long and 0.5–1.0 mm broad.

Discussion

The close structural relationship of the ganglion to the pterygopalatine nerve in the hedgehog can be explained by its ontogenesis. In mammals, the precursor of the pterygopalatine ganglion appears at the site of contact of the pterygopalatine nerve with the petrosal major nerve. The close connection between these structures can be

seen in the illustration of the fifty-four post-conception baboon embryo (Gasser and Hendrickx 1969). At this stage of development branches of the pterygopalatine nerve are distinctly shaped and highly integrated at their root ends with the pterygopalatine ganglion. Additional evidence for the common development of both structures is the position of postganglionic nerve bundles among ramifications of the pterygopalatine nerve and that both structures innervate the mucous membrane of the nose and of the palate as well as glands. Therefore, it is not surprising that there is a close relation between the course of the nerve and the position of the pterygopalatine ganglion, which in mammals can lie above or, at the level of, or below the maxillary nerve. If branches of the pterygopalatine nerve run upwards to the paracentral surface of the gland of Harder, then this is where the ganglion is positioned, as for example in the guinea pig (Gienc and Kuder 1982). On the other hand, if the root section of the pterygopalatine nerve runs parallel with other bundles of the maxillary nerve, then the ganglion is found at the dorsal or paracentral surface of the nerve. This is where the pterygopalatine ganglion is situated in most mammals, including the hedgehog (Grau 1943, Ruskell 1965, Godinho 1968, Nitschke 1976, Kuder 1983, 1985).

If branches of the pterygopalatine nerve are directed downwards, which is the case in man and other primates, the ganglion lies below the maxillary nerve (Żabotyński 1953, Sadowski *et al.* 1970, Ruskell 1971).

Cell density in the pterygopalatine ganglion in mammals may be either high or low (Gienc 1984). The guinea pig is an example of the latter situation and its pterygopalatine ganglion is characterized by small, dispersal groups of cells situated in numerous microganglia (Gienc and Kuder 1982). The wild boar has also been shown to have a low cell density in the pterygopalatine ganglion. In this species, microganglia are dispersed in a network formed by bundles of nerve fibres, which is referred to as the plexoganglion (Petela 1979). The pterygopalatine ganglion in the horse is of similar structure, but in this species it can also be composed of a single, dense agglomeration of cells (Grau 1943). A slightly higher degree of cell density is found in domestic ruminants, where the number of ganglia is reduced to between 4 and 8, and their dimensions increase to such an extent that they are usually visible to the naked eye (Godinho 1968). In the majority of mammals however, there is a single pterygopalatine ganglion with densely packed cells with the possibility that there may be tiny additional ganglia (Ruskell 1965, Nitschke 1976, Kuder 1983, 1985). In the hedgehog ganglionic neurocytes are loosely packed, but there are no satellite ganglia.

If we assume that this shape of the ganglion is rudimentary for other orders of mammals, then the dispersion of ganglionic cells which occurs in some species could be merely coincidental specific to that species and not connected with the phylogensis, as has been suggested by Kuder (1985). This latter suggestion is contradictory to the view that there is a tendency towards accumulation of the cells in autonomic ganglia in mammals (Gienc 1984). The problem requires further research, especially examination of a greater number of species belonging to the *Insectivora*.

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